

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY


(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 29 DEC 2005

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Applicant's or agent's file reference CAS 0438	<b>FOR FURTHER ACTION</b>		See Form PCT/IPEA/416
International application No. PCT/CH2005/000064	International filing date (day/month/year) 04.02.2005	Priority date (day/month/year) 06.02.2004	
International Patent Classification (IPC) or national classification and IPC H02P6/18			
Applicant MICRO-BEAM SA et al.			
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau a total of 4 sheets, as follows:</p> <p style="margin-left: 40px;"><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p style="margin-left: 40px;"><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>			
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>			
Date of submission of the demand  22.11.2005		Date of completion of this report  30.12.2005	
Name and mailing address of the international preliminary examining authority:   European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016		Authorized Officer  Davis, A  Telephone No. +31 70 340-2097	



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ON PATENTABILITY**

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PCT/CH2005/000064

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**Box No. I Basis of the report**

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1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4)
  - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements\*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

**Description, Pages**

1-11 as originally filed

**Claims, Numbers**

1-10 as amended (together with any statement) under Art. 19 PCT

**Drawings, Sheets**

1/4-4/4 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

Novelty (N)	Yes: Claims	1-10
	No: Claims	
Inventive step (IS)	Yes: Claims	
	No: Claims	1-10
Industrial applicability (IA)	Yes: Claims	1-10
	No: Claims	

2. Citations and explanations (Rule 70.7):

**see separate sheet**

**V Reasoned statement**

1 Reference is made to the following documents:

D1: US-A-6,653,829

D2: US-A-6,005,364

2 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 does not involve an inventive step in the sense of Article 33(3) PCT.

3 The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses:

a method for controlling a synchronous permanent magnet multiple-phase motor in which a position sensor is used (see Fig.3 ref. 14) to supply the data for a state filter (see column 12 lines 26 to 34) to derive an estimated value of position in addition to that sensed.

4 The subject-matter of claim 1 therefore differs from this known method in that in the claim the back EMF of the unexcited phases is used to calculate position.

5 The problem to be solved by the present invention may therefore be regarded as how to reduce the hardware cost of the method of D1 by for example removing the encoder.

6 The solution proposed in claim 1 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) since the use of the back EMF of unexcited phases to detect position is well known in the art as seen for example in D2 (see column 12, lines 24 to 56 and column 13 lines 59 to 63).

6.1 It is noted that D2 may also serve as the closest prior art to demonstrate that unclear claim 1 lacks an inventive step over the prior art (Article 33(3) PCT).

7 A similar reasoning to that of independent method claim 1 applies also to the subject-matter of the corresponding independent apparatus claim 7, which therefore

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is also considered not inventive. It is noted that claim 7 appears to intend to include the subject matter of "means for computing" the presence of the state filter which is referred to in claim 1.

- 8 Dependent claims 2 to 6 and 8 to 10 do not appear to contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, see documents D1 and D2 and the corresponding passages cited in the search report.
- 9 A minor lack of clarity (Article 6 PCT) arises in claim 1 with the expression "with a sensitivity allowing to obtain significant values..." since this appears to be a relative phrase and does not make clear what "significant" relates to. A similar lack of clarity arises in independent apparatus claim 7 with the expression "high enough gain to provide significant output signals...", since it also contains a relative phrase not allowing a comparison with the prior art which also uses such "detection means".

22 11. 2005

## CLAIMS

(68)

1. A method for controlling a synchronous permanent magnet multiple-phase motor, comprising the steps of:

- 5           - controlling the drive current supplied to each motor phase by turning it off at a predetermined frequency,
- measuring, at said predetermined frequency, the induced voltages of at least two motor phases, when the power in said motor phase is
- 10           turned off, with a sensitivity allowing to obtain significant voltages values at near-zero speed,
- determining the rotor position and/or the rotor speed from signals resulting from said measured induced voltages,
- entering said determined rotor position and/or said determined rotor speed into a state filter which delivers a filtered rotor position and/or
- 15           a filtered rotor speed, and
- adjusting the drive current as a function of said filtered rotor position and/or filtered rotor speed.

20       2. The method according to claim 1, wherein the state filter is arranged so as to take into account that when the speed of the motor is very low, the position of the rotor can not change substantially over a short period of time.

25       3. The method according to claim 2, wherein said state filter is a Kalman filter.

4. The method according to any of claims 1 to 3, wherein the measured position  $\theta$  of the rotor is determined by the formula

$$\theta = \text{Artcg} \frac{U_a}{U_b}$$

where  $U_a$  is equal to the measured induced voltage in one phase and  $U_b$  is equal to  $\frac{V_2 - V_3}{\sqrt{3}}$ ,  $V_2$  and  $V_3$  being the measured induced

5 voltages in the other two phases.

5. The method according to any of claims 1 to 4, wherein the measured speed of the rotor is determined by computing the square root of the sum of squares of measured induced voltages.

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6. The method according to any of claims 2 to 5, wherein the said state filter implements an algorithm such as

$$X = X_{-1} + (a * V * T + b * dP) \div 2,$$

where  $X$  is the estimated position at time  $t$ ,

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$X_{-1}$  is the estimated position at time  $t_1$ ,

$X_m$  is the measured position using back EMF voltages at time  $t_m$  with  $(t_1 \leq t_m \leq t)$ ,

$V$  is the measured speed using back EMF voltages at time  $t_m$ ,

$T$  is the time duration between 2 successive measurements ( $t_1$  and  $t$ ),

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$dP$  is the difference between  $X_m$  and  $X_{-1}$ , such difference being however limited to  $\pm(c * VT + d)$  and  $a$ ,  $b$ ,  $c$  and  $d$  are coefficients which depend on the motor characteristics.

7. An electronic device for controlling a synchronous permanent magnet motor (1) with at least one phase, a coil, a rotor and a motor driver (2), comprising

5 detection means (3), which are connected to the phases (A, B, C) of the motor and deliver signals that represent induced voltages of motor phases, said detection means having a high enough gain to provide significant output signals even if the speed of the rotor is near-zero, and

10 a control circuit (4) connected to said detection means and to the motor driver (2), which supplies driving currents to the motor, said control circuit comprising means for computing the position and/or the speed of the rotor from the output signals provided by said detection means.

- 15 8. The electronic device according to claim 7, wherein said detection means comprise, for each phase of the motor, a differential amplifier (31, 32, 33) the inputs of which are connected to two different phases of the motor and an analog-to-digital converter (34, 35, 36) to convert the analog signal outputted by said differential amplifier into a digital signal, 20 which is applied to said control circuit.

9. The electronic device according to claim 7 or claim 8, wherein the control circuit further comprises a state filter for filtering signals representing the position and/or the speed of the motor determined from the output 25 signals of said detection means.



10. The electronic device according to claim 9 wherein said state filter is a Kalman filter.
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